(1.1) $x(t)=\cos(2\pi f_0 t)$, $f_0=125Hz$
$f_s=1000Hz$, $N=64$

1) $T_s=\frac{1}{f_s}=\frac{1}{1000}=10^{-3}s$

2) $\Delta f=\frac{f_s}{N}=\frac{1000}{64}=15625Hz$

3) $f_k=k\cdot\Delta f=k\frac{f_s}{N}$, $k=0,1,\dots,N-1$

$f_0=125Hz \Rightarrow k=\frac{f_0}{\Delta f}=\frac{125}{15625}=8$

(1.2) $x(t)=\cos(2\pi f_0 t)$, $f_0=130Hz$
$f_s=1000Hz$, $N=64$

1) $\Delta f=\frac{f_s}{N}=15625Hz$

2) $f_0=130 \Rightarrow k=\frac{f_0}{\Delta f}=\frac{130}{15625}=8.32$

$k=8$

(1.7) $x(t)=\cos(2\pi 100t)+\cos(2\pi 105t)$
$f_s=1000Hz$

1) $N_1=100 \rightarrow \Delta f_1=\frac{f_s}{N_1}=\frac{1000}{100}=10Hz$

2) $N_2=1000 \rightarrow \Delta f_2=\frac{f_s}{N_2}=\frac{1000}{1000}=1Hz$

3) $105-100=5Hz=\Delta f$
$N_1 \rightarrow \Delta f_1=10Hz$ $\Delta f_1>\Delta f$
$N_2 \rightarrow \Delta f_2=1Hz$ $\Delta f_2<\Delta f$

(1.18) $A_1=1$, $A_2=10^{-9}$ $A_1\sim 10^{-7}>A_2$

1) $DR=\frac{A_1}{A_2}=\frac{1}{10^{-9}}=10^9$

2) $DR_{dB}=20\log_{10}(DR)=$
$=20\log_{10}(10^9)=20\cdot 9=80dB$

3) (1) Παραβόλα με < side lobes
(2) Αύξηση παραμέτρου Δf

(1.32) $f_s=1000Hz$, $N=128$
$f_0=160Hz$

1) $\Delta f=\frac{f_s}{N}=\frac{1000}{128}=7.8125Hz$

2) $K_0=\frac{f_0}{\Delta f}=\frac{160}{7.8125}=20.48$

3) $k=20$

4) $f_{20}=k\cdot\Delta f=20\cdot 7.8125=156.25Hz$
$|f_0-f_{20}|=|160-156.25|=3.75Hz$

156.25 $=f_{20}$

(1.28) $A=1$, $CG=0.5$

1) $A'=CG\cdot A=0.5\cdot 1=0.5$

2) $\frac{1}{CG}=\frac{1}{0.5}=2$

3) $A_c=\frac{A'}{CG}=\frac{0.5}{0.5}=1$

(1.33) $f_1=100Hz$, $f_2=106Hz$
$f_s=1000Hz$

1) $\Delta f=\frac{1}{T} \Rightarrow \Delta f\le 2Hz$
$\Rightarrow \frac{1}{T}\le 2 \Rightarrow T\ge 0.5sec$

2) $N=f_s T=1000\cdot 0.5=500$ samples

3) $\Delta f=2Hz$
$f_2-f_1=106-100=6Hz$ } $\frac{6}{2}=3$ bins